Superfluidity in Water

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I want to argue that Superfluidity can be accounted for by surface energy. To be specific: superfluid (SF) Helium (always He 4) wets any surface and creeps out any container.
Pressure increase improves contact between fluid and wall and we might assume that the surface energy lowers itself with increasing pressure, at least in a certain pressure range.
This assumption is enough to derive permanent circular currents and resistanceless flow through capillaries.
For the circular currents, see figure 1: a circular flow near the outer wall needs a centripetal force which is furnished by a pressure gradient. The resulting higher pressure at the outer wall will lower the surface energy.

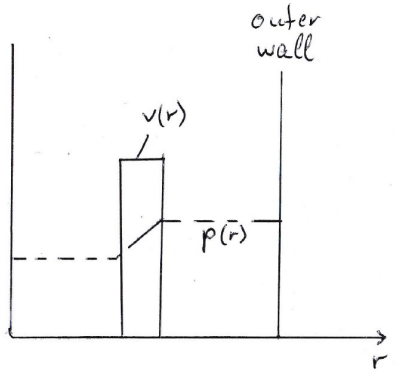

fig.1

When the total energy, kinetic energy plus surface energy are lower than the current-less state, the current-carrying state will be thermodynamically favored.
This is not even a metastable state, but the actual lowest-energy thermodynamic state.
It can be created by rotating SF Helium; there is no need to cool through the SF temperature.

In a capillary, a circular current around the capillary axis will lower energy. If the capillary is formed like a screw (see figure 2), this circular current always must have a forward motion, otherwise it is geometrically impossible.
We might assume, that capillary walls are rugged and qualify as screws.

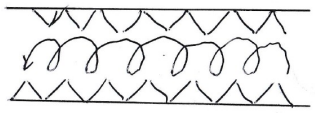

fig. 2

The centrifugal force of circular currents is proportional to 1/R, R being its radius. The smaller the radius, the easier a pressure increase can be created. When the diameter becomes too big, the cost in kinetic energy can become too high and no superfluid currents are possible anymore.

This behaviour is not specific to SF Helium but could be found in any suitable wetting fluid-solid combination. Even water could be superfluid.
Applications can include gyroscopes for circular currents but, more importantly, biological systems for longitudinal flow.

The surface behaviour can give us a clue about the nature of the SF state.
What does a surface do? It structures.
Helium can more easily form an *extended crystal* near a surface.
We might assume the SF state to be formed like a polycrystal whose joints are - voids.
That way, cristalites remain flexible and can flow.
This suits well with the dip in density below T_λ .
It also helps to understand the lambda behaviour of specific heat (SH):
The SF state is a crystal in disguise. A crystal-liquid transition shows a deltafunction peak in SH.
Here, the peak is extended over a finite temperature range.
It would be interesting to create single-crystal Helium, drawing inspiration from the making of single-crystal turbine blades.
From what has been said, it would not be a stretch to suspect it to be the actual low-temperature phase of Helium.
But there is only one way to find out.